Leaming (Jas. R.)

RESPIRATORY MURMURS.

BY

JAMES R. LEAMING, M. D.,

ONE OF THE VISITING PHYSICIANS TO ST. LUKE'S HOSPITAL, NEW YORK.

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SECOND EDITION, REVISED AND ENLARGED.

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RESPIRATORY MURMURS.[1]

Since the time of Laennec, those engaged in investigating physical conditions of the chest have ever united in looking to the breath-sounds for the elementary key.

Able and distinguished men have given much of their lives to the consideration and practice of auscultation, but certainty in diagnosis in incipient disease is yet vainly desired. It must be that the method of study has been faulty, or that attention has been wrongly directed. Under these circumstances, presumption may be pardoned, even if it should fail in the attempt to show a better way.

Laennec recognized both bronchial and pulmonary breath-sounds, and explained them as being caused by air-friction. In describing pulmonary respiration, he says: "On applying the cylinder, with its funnel-shaped cavity open, to the breast of a healthy person, we hear, during inspiration and expiration, a slight but extremely distinct murmur, answering to the entrance of the air into and expulsion from the air-cells of the lungs. This murmur may be compared to that produced by a pair of bellows whose valve makes no noise, or, still better, to that emitted by a person in a deep and placid sleep, who takes now and then a profound inspiration" (Forbes's Laennec, p. 29); and the translator adds in a foot-note: "It will be most easily and distinctively perceived by applying the naked ear to the chest of a child." Laennec's view is theoretical, not based on a careful study of all the facts. Indeed, at that time the

[1] Read before the Academy of Medicine, January 4, 1872.

minute anatomy of the lung, and the constitution of the residual air, were not known. Subsequent opinions have been influenced more or less by Laennec's, especially in this, that all respiratory murmurs are considered to be air- and tube-friction sounds. Many differ from him as to the seat, but all agree with him as to the mechanism. M. Beau, of Paris, placed its seat in the pharynx; Dr. Sanderson, of Edinburgh, in the rima glottidis. Skoda, of Vienna, considered vesicular murmur as occurring only in inspiration, and being caused by air-friction, and he likened it to the noise one makes in forcing the air through the nearly-closed lips. He denies that the respiratory murmur has any thing to do with the vesicular breathing, which, he says, is a purely bronchial sound. Andral called it a sound of pulmonary expansion or vesicular respiration, thus designating its seat, and giving it name.

Many speak of vesicular and respiratory murmurs as interchangeable terms. The late Dr. Hyde Salter placed the seat of the respiratory or vesicular murmur in the convective system, and mostly in the sub-pleural, minute bronchioles (*British and Foreign Med.-Chir. Rev.*, July, 1861). Dr. Waters, of Liverpool, whose prize essay on the minute anatomy of the human lung has done so much to increase our knowledge on this subject, describes the mode of connection of the bronchioli with the air-sacs. The opening sometimes is, as it were, a hole punched out, clean and round, and the air, passing in and out, must make a sound much in the same way as is done in a toy tin whistle. The late Dr. Cammann, of this city, believed the cause of the murmur to be the passage of air into the air-sacs and out again. Dr. Williams, after speaking of portions of the chest where blowing sounds are heard, goes on to say: "Then there is the vesicular respiration, which is heard in most other parts of the chest; it is a diffused murmur caused by the air penetrating through the minutest tubes, and into their numerous vesicles or cells." Dr. Gerhard, of Philadelphia ("Lectures on the Diagnosis, Pathology, and Treatment of Diseases of the Chest"), says: "The sound of air entering the vesicles is different from that caused by its passage through the tubes, and the former is, therefore, known as the vesicular sound, the latter as the tubal or blowing sound. The vesicular sound is often called a murmur, from its softness and diffu-

sion over a large space, and cannot be produced unless the vesicles are healthy or nearly so." And again he says the cause of difference "seems to be the different manner in which the air impinges upon the vesicles and tubes. But the vesicular sound is in part owing to the vibration of the air, and in part to the noise produced by the dilating of the vesicles themselves."

Dr. Walshe represents the natural respiratory murmurs as caused by inspiration and expiration, for which there is usually a healthy type, "commonly termed—*a*, pulmonary or vesicular; *b*, bronchial; *c*, tracheal; *d*, laryngeal; *e*, pharyngeal, according to the part of the respiratory apparatus from which the sounds audible externally are transmitted." Dr. Corrigan divides the sounds heard in auscultation into "simple sounds or murmurs, and compound sounds or rattles. . . . All the sounds heard in the chest belong to one or the other of those two kinds; and, if, when you hear a sound, the exact nature of which you may be in doubt, you will first refer it to its class, your labor in determining what it is will be very much diminished." The American editor of "Stokes on the Chest" describes vesicular murmur as that "of a soft and gentle, or, as it has been otherwise described, a mellow, continuous, gradually-developed, breezy murmur, unattended with a sensation either of dryness or humidity; and we are properly cautioned by M. Fournet and his reviewer not to expect a character of sound which conveys the notion of a successive dilatation of separate vesicles, or, as it is sometimes called, pure and vesicular." Dr. Hyde Salter says: "There is another reason, to which I have not referred, which makes me think that the respiratory murmur must have a tubular or *quasi* tubular seat, and cannot be formed in the air-cells; it is, that fine crepitation, such as that of pneumonia, *supplants* it; it does not merely drown it, it supplants it, the two do not coexist;" and farther on: "If, then, pneumonic crepitation is a veritable tube-sound, and its seat the microscopical tubes immediately subtending the air-cells, the supplanting and destruction of the respiratory murmur by it would show that this latter has an identical seat, and is therefore a tube-sound." This explains Dr. Salter's views as to the seat and cause of the murmur. He believes it to be caused by the passage of air through

these microscopic air-tubes, just before they reach the vesicles; and, as he is one of the latest and most brilliant writers on this subject, perhaps he represents the more advanced views of the profession. He does not deny that sounds formed anywhere in the convective system, from the mouth or nose to the smaller bronchiæ, mingle with and enter into the composition of the respiratory murmur, but he denies that the air-vesicles or alveoli have any thing to do in forming the sound. He believes the sound is formed in the bronchioles, immediately subtending the pulmonary pleura.

Carefully examining the opinions of different writers, it is evident that some consider the respiratory murmur as having a single seat and cause, while others recognize its composite character. Yet, I am not aware that any one has ever attempted to analyze the murmur, and study its constituents separately as well as together. They speak of the vesicular character, the pulmonary quality of the respiration, but they attempt no analysis. To show that this may, and ought to be done, in order to attain unto a higher grade of excellence in diagnosis, is the main object of this paper. A clear understanding of this whole matter will make it necessary, as preliminary, to look at the minute anatomy of the tissue of the lungs, and of the bronchial system; secondly, the circulation of the lungs and of the bronchial system; and, thirdly, the characteristics and constitution of the residual air, its object and office. The bronchial system may be, and is frequently, called the convective or the broncho-respiratory system, and the pulmonary is called the true respiratory system. They differ in almost every respect. The office of the broncho-respiratory is to convey air into the true respiratory system, while the true respiratory system is where the great function of vitalizing the blood is perfected. The bronchial system is characterized by cartilage in its fibrous sheath. In the upper part, where it is necessary to prevent collapse of the tubes, the cartilage is in nearly perfect rings, but as the tubes pass into the lung-structure, where they are occupied by the residual air, the cartilage gradually loses the character of rings, and appears merely as deposits occurring at irregular intervals, down so far as the bronchial arteries extend, to where the bronchial veins commence to carry back the blood that has passed

through the capillaries of the bronchial mucous membrane. The mucous membrane also, of the broncho-respiratory system, is different from that of the true respiratory system, in this, that it is ciliated epithelial mucous membrane, while the other is of tesselated basement epithelium. The circulation also is entirely different. The convective system is supplied by the bronchial arteries; the pulmonary substance by the pulmonary artery, and by the nutrient arteries of the lungs, which are the connecting link between the two systems. The nutritive arteries arise from the bronchial arteries, but have no accompanying veins. Thus, blood, after performing the proper office of nutrition in the pulmonary tissue, is at once reaërated, and passes into the venous radicles of the pulmonary vein prepared for systemic circulation.

The bronchial arteries have been called the nutritive arteries by anatomists, but they have not dwelt upon the fact that the *venæ comites* do not attend these arteries into the pulmonary structure, and that, consequently, this gives them a peculiar character. The bronchial veins return all the blood of the bronchial arteries; the nutritive arteries have no veins. Their blood is reaërated where they do their work, and it finds its way into the venous radicles of the pulmonary vein as arterial blood. This anomaly in the circulation is of great interest in explaining physiological causes and pathological effects. In pneumonia, it is the nutrient artery, accompanied with its plexes of ganglia of the organic nerve, lymphatics, etc., that preserves the life of the part, and governs the whole process of resolution. We can all remember the anxiety of practitioners, in the past, to prevent abscess and gangrene of the lung after inflammation. But time, and a more careful study of the natural history of the disease, have proved to us that gangrene and abscess are rare accidents, even when no treatment at all is had. This peculiar arrangement of the nutrient artery gives us an early knowledge, in many cases, of commencing phthisis. Occupation of the air-sacs by tubercle interferes with the circulation, and blood is thrown back upon the bronchial artery, and the result is bronchorrhagia, a conservative act; for, like the application of leeches, it sets the absorbents actively at work to remove the cause—the new tu-

bercle. And, in this way, cases of early phthisis are self-cured, or, at all events, ameliorated, and the physician is guided in his treatment.

This singular fact in the circulation was discovered by the late Dr. Cammann, in making his experiments to prove the non-anastomosis of the arteries of the lung. Using a colored fluid suitable for fine injections, he found that, when he injected the pulmonary artery, the fluid returned easily by the pulmonary vein; but, injecting the pulmonary vein, the fluid not only passed into the pulmonary artery, but, if the injection was carefully continued, it would also find its way into the bronchial arteries. Then, again injecting the bronchial arteries, he found that the fluid after a little time passed into the pulmonary vein; this proved that there was communication between the bronchial arteries and the pulmonary vein, but not with the pulmonary artery. This was shortly after 1840, and before, I believe, any experiments had been made in Europe, in regard to this circulation. Since then, several observers have come to nearly the same conclusion. Drs. Williams and Adriani believe "the vessels of the bronchial mucous membrane terminate in the pulmonary veins, and those of the deeper plexus in the bronchial veins." Dr. Waters says, after explaining his experiments, which were very full and minute: "That a distinct and free communication exists between the bronchial vessels and the pulmonary veins, admits of ocular proof. I have seen, with the aid of the dissecting microscope, the small vessels passing from the outer surface of the bronchial tubes, and forming a small trunk, which terminated in a pulmonary vein." Dr. Waters also says: "It may be said that such a view militates against the generally-received opinion of the purity of the blood returned to the left side of the heart, for, if the bronchial blood is poured into the pulmonary veins, it is returned to the left auricle without undergoing the process of aëration. I would answer that the view I have taken is supported by anatomical facts, a basis on which all physiological theories should be founded." I remember that Dr. Cammann, also, could not reconcile the incongruity of the apparent fact that venous blood passed directly into the aërated blood of the pulmonary vein, and then to the left heart. Both of these gentlemen

overlooked the truth that the blood from the nutrient artery passes through capillaries in the true respiratory system on its way to the radicles of the pulmonary vein, and, of course, is reaërated. Dr. Robert Lee, if my memory serves me (for I have not the paper at hand), says that the extension of the bronchial artery, after it has quit company with the vein, receives additions from the mammary and intercostal arteries, and has the proper title of nutrient artery. I do not quote his words, but the substance as I remember it.

I believe, then, I am warranted in holding that there is a complete difference in the blood-vessels of the convective and of the pulmonary systems. The nutrient arteries of the bronchial system have their venæ comites; the nutrient arteries of the true respiratory system have no accompanying veins, but pass their blood reaërated directly into the pulmonary vein, prepared for systemic circulation. The nutrient artery is no exception to the rule of complete difference in the two systems, for in its office it belongs wholly to the true respiratory. The vessels of the bronchial system are the bronchial arteries and veins; the vessels of the true respiratory are the pulmonary artery and vein, and the nutrient artery of the lungs.

Where the bronchial system ends the pulmonary begins, and the division is sufficiently marked—it is where cartilage ceases and alveoli commence. The structure of the true respiratory system is composed of terminal bronchii, in which are developed alveoli and the air-sacs, that is, wherever alveoli are found. Its whole object or office is aëration of the blood of the body. It is greatly distensible, and in this differs from the convective system, which is but little so, and its formation evidences design in the economy of space and for its especial purpose. The bronchioles have alveoli developed in their sides, but not to the same extent as in the air-sacs, which are but a skeleton net-work for the convenient spreading out of alveoli, with their rete mirabile of capillaries, for the aëration of the blood. The terminal bronchus enlarges at its end, and the air-sacs are developed from this enlargement, according to Dr. Waters, as a cluster of leaves are, sometimes from the end of a twig. From six to thirteen of these air-sacs are in connection with the enlarged end of a terminal bronchus, and this little cluster forms a lobulette—a complete type of the

whole lung. Each lobulette has its terminal bronchus and air-sacs for the development of alveoli, its twig of pulmonary artery and vein, its branch of nutrient artery, with the accompanying gangliæ of organic nerve, lacteals, absorbents, etc. A collection of lobulettes form a lobule, and a number of these constitute a lobe. The fibrous bands of the bronchial sheath are continued, though with great tenuity, through the terminal bronchi into the air-sacs, both of the white and yellow variety. They surround the mouth of each air-sac, and give firmness to the frame of each alveolus. Muscular fibres also accompany these bands, though their presence is doubted on account of their extreme tenuity. Niemeyer speaks of muscular fibres as present in the true respiratory system. In emphysema, the air-sacs lose their power of contraction, and become dilated, causing great suffering and disability to the patient. Time and freedom from catarrh allow the function of contraction, which is a muscular habit, to return.

Physiologists describe residual air as filling the respiratory system as high up as the third or fourth divisions of the bronchiæ. It not only fills the true respiratory system, but distends it. The elements of the distending force are : atmospheric pressure, muscular contraction, rarefaction, and the laws of diffusion of gases, and that of affinitive attraction between oxygen and venous blood. The residual air occupies its position with such persistence as to be with difficulty dislodged after death, even with much pressure. It keeps its place with vastly greater tenacity, during life, when each element of force is in active operation.

During inspiration, the contraction of the diaphragm increases the capacity of the chest, and at the same time the epiglottis is raised, and the weight of the atmosphere operates actively in dilating the lungs. Rarefaction of the newly-inspired air takes place upon inspiration, owing to its immediate and intimate admixture with the residual air, and is the third element of dilating force. The residual air is estimated to be 170 cubic inches, and the inspired air at 20. At each inspiration, therefore, the residual air will be increased about one-tenth part in dilating power, *plus* the rarefaction of the

inspired air. But the peculiar elements of this expanding force are, the laws of the diffusion of gases, and that of the affinitive attraction between the unaërated blood-globules, in the capillaries of the rete mirabile of the alveoli, and the oxygen, which is equally distributed throughout the residual air. Chemistry demonstrates that gases differently constituted in certain relations instantly intermix when brought together. The inspired air and the residual air present these differences. Air entering the convective system moves in a body through the bronchial tubes, till it meets the residual air, when, the law of the diffusion of gases operating, immediate admixture takes place. The residual air is instantly renewed with oxygen, in accordance with this law. The inspired atmospheric air moves through the convective system, as far as the fourth division of the bronchiæ, with no other resistance than the friction of the tubes. When it meets the residual air, it is immediately consumed, as it were, and does not accumulate, causing resistance. On this account the inspired air moves with increasing velocity, producing air- and tube-friction murmur. Tidal air in health is only heard in inspiration. Velocity of the moving air in the tube is the cause of murmur. Any one may demonstrate this fact by breathing through a tube gently, when there will be no murmur, but, if he increase the velocity of the moving air, he will get sound, which will be increased in sonority and raised in pitch just in accordance with the rate of motion. In health, in unconscious breathing, expiration is not heard, and we know by experience that, when it is heard in unconscious breathing, there is disease; it may be phthisis, or it may be emphysema—other conditions must determine which. A murmur may be produced at will, by hurrying the respiration. It is heard in systemic diseases like cholera, or in diseases of particular organs, as in cardiac apnœa, or Bright's small kidney. The cause of murmur, in air moving in a tube, no matter what are the other conditions, or the disease, is the *velocity*, increasing the air- and tube-friction.

Prof. John W. Draper has given a convincing explanation, based on accurate experimentation of affinitive attraction in the systemic capillaries, as one of the efficient causes

of the circulation. The same power operates in the pulmonic circulation, but with this important addition, that the attraction is not alone in the pulmonic tissues and the blood, but principally in the venous blood and the oxygen of the residual air. This is the cause that brings the venous blood and oxygen together, in order that the blood may be purified and fitted to continue the life of the body. Let us endeavor to comprehend the intricate mechanism of the respiratory act. Inspiration has taken place—twenty cubic inches have been added to the residual air, evenly and equally admixed—dilatation has taken place with force, and is continued and increased by the rarefaction of heat. The true respiratory system, by its muscular power, contracts forcibly, antagonizing the dilating residual air. Each particle of pure air, acknowledging its attraction for the venous blood, presses up to the alveolus, through the struggling mass, and rushes to the blood-globule in the capillary—makes the interchange—gives up its oxygen, and receives in return detritus and carbon materials, loses its attraction, becomes passive, but is crowded back by other eager particles pressing forward, until finally it finds itself well up in the bronchus, with its filthy load, whence it is expired. The blood-globule from the pulmonary artery, entering the capillary of the alveolus, hurries along through the rete mirabile, drawn by its affinity for oxygen, till it meets a particle of pure air, makes the interchange, loses its activity, but is pushed onward by other globules pressing forward from behind, till it finds itself in the venous radicle of the pulmonary vein, fitted for systemic circulation. The movement of the blood-globules is much assisted by the contraction and relaxation of the muscular fibres of the true respiratory system. Different bundles of these fibres, contracting and relaxing in succession, give not only a living vibratory motion, which assists in hurrying the globules along, but produce a susurrus, which, being heard at the chest-wall in multitudinous concert, is true respiratory murmur. These facts in minute anatomy and physiology (and they hardly admit of any dispute) prove that the residual air, as a body, has no more motion than has the bottom of the deep sea. No change can occur except molecular, and none other is necessary. The

law of diffusion of gases assures the comparative purity of the residual air, as well as its constant and guarded impurity, which is so necessary for the accomplishment of the vital act. The circulation would not go on, if each blood-globule should immediately come in contact with pure air, for then it would lose its impelling force, and, all of the globules alike losing their attraction, there would be stasis. Instead of this, both in the blood and the residual air each globule and each air-particle moves in perfect order, never in each other's way. This shows how the individual may live in bad air for a time, resisting its evil tendencies, and even that of poisonous gases. It shows also why medical inhalations fail in their object. Medicated vapors have little or no admission into the residual air. Even oxygen gas, which is sometimes serviceable, can only supply atmospheric deficiencies. It can neither do the harm nor the good that has been predicated for it. An animal may even live for a time in pure oxygen gas, the active interchange taking place between the gas and the blood restoring the necessary grade of impurity in the residual air.

If, then, the only change or motion that is possible in the residual air be molecular, what becomes of the theories of air- and tube-friction murmurs, whether in the smaller bronchiæ or the air-sacs and alveoli, as cause of the so-called vesicular murmur? They are physical impossibilities. And, too, what becomes of the theories of the mechanism of crepitant *râle?* If there is no motion but the molecular, there can be no bursting of bubbles in the microscopic tubes, and that theory falls. If the residual air constantly and forcibly distends the true respiratory system, how can the bronchioles and air-sacs come together, to be separated by each inspiration of fresh air, so as to produce fine crepitant râle? This theory, likewise, supposes a physical impossibility. All theories, whether of vesicular murmur or crepitant râle, which ignore the presence of the residual air, are of necessity incompetent. The fact that residual air has none but molecular motion may be demonstrated by a distensible bag, as of India-rubber. While it is being forcibly filled with air, there will be air- and tube-friction murmur at the mouth only, where the air moves in a body with velocity. The body of air in the bag will be in-

creased by particles of air sliding in among each other and without sound. But there will be resisting vibratory sound in the walls of the tense dilating bag; different, however, from that of the contracting true respiratory murmur in this, that it is only heard during dilatation, while the other is continuous, because owing to active muscular contraction. Dr. Hyde Salter says, after speaking of the occupancy of the true respiratory system by residual air, and that about twenty cubic inches of atmospheric air are added at each inspiration: "Each air-cell is, therefore, a tenth larger at inspiration than at expiration. Now, it is inconceivable that this slight variation in the capacity of these shallow open concavities should be attended with any sound. I cannot conceive it possible. For, be it remembered that the air-cells are not nearly-closed cavities communicating by constricted orifices with the general cavity of the lobular passage, but wide-mouthed and patulous like a teacup. And be it remembered, too, that in respiration the air is not pumped out of and into the cells, but, as they undergo this slight change of volume, a small part of their contents passes just without them, and then again, on their recovering their capacity, from without just within them, if one can speak of 'within' and 'without,' in reference to such slight interchange of situation. For, really, the renovation of the air in the tissues of the lung does not depend on its actual removal, but upon the law of the diffusion of gases."

This reasoning is cogent and unanswerable. It proves beyond cavil that there is no motion in the air-sacs and alveoli to produce air- and tube-friction sound, and yet he attempts to show that there is such motion in the smaller bronchiæ and intralobular passages. He says: "But while the movement of the air at each alveolus would be so slight, so almost inappreciable, the collective expansion of all the alveoli common to a lobular passage, and the consequent abstraction of air from the general cavity, would be considerable, and would create a considerable rush of air into the lobular passage to supply its place, for the modicum of air, however small, appropriated by each dilating air-cell, would of course be multiplied by the number of cells communicating with the common axial cavity of the lobular passage."

Dr. Salter's able reasoning shows that there is not enough motion in the alveoli or air-sacs to cause sound, and the same reasoning applies with equal force to the air in the bronchioles and intralobular passages. The residual air occupies these passages just as well as it does the air-sacs; one-tenth is added at each inspiration to the whole body of residual air, and Dr. Salter himself has said that these small bronchial tubes were largely distensible, consequently the velocity of motion in these passages where alveoli are developed must be too little, if there be any at all, to produce any sound. There certainly can be no rush; indeed, I have already shown that there can be no motion, except the molecular. But, for argument's sake, if there should be motion in these minute tubes, as Dr. Salter claims, it could not possibly have the velocity necessary to cause sound. Dr. Salter's argument to prove that the seat of crepitant râle and the seat of respiratory murmur are the same—"The râle supplants the true respiratory murmur, the two do not coexist"—heretofore quoted, is convincing. Had he placed the seat in the air-sacs and alveoli as well as in the terminal bronchioles, he would have been correct, for then he must have acknowledged that it could not be by tube- and air-friction, and he would have been forced to accept the true explanation, that of dilatation and contraction. Crepitant râle indicates the commencement of the process of inflammation, and it supplants the true respiratory murmur. Let us study the evidence in the light of the true respiratory murmur.

If you have lately examined the chest of a person in health, and have noted the murmur in its fulness and perfection, and should be called to see him suffering from a chill, with pain in the head, back, limbs, etc., and should again examine the respiration carefully, you will still hear the true respiratory murmur, but it will be obscured or muffled. All the capillaries of the lung are crowded with blood, and this is the explanation of the muffled murmur. If you wait a few hours, and again examine him, you find the true respiratory murmur absent, and, in place of it, the fine crepitant râle. The congestion of the capillaries of the lung still remains; there is scarcely a perceptible difference in the percussion-note; the residual air still occupies its seat in the true respir-

atory system, and it still continues to dilate the air-sacs, alveoli, and terminal tubes. Whatever change has taken place, must have been at the seat of the true respiratory murmur.

In tissues that may be seen, what is the first result of inflammation? Is it not that plastic material is thrown out into the connective tissue? This, also, must take place in the lungs. The connective tissue of the lungs, delicate as it is, has been filled with plastic material. It has become thickened and stiffened, it cannot contract, and the true respiratory murmur is gone, but it must yield, though unwillingly, to the dilating force of the residual air, increased one-tenth at each inspiration, separating newly-formed plastic exudations, causing sound, which we hear as fine crackling, and call it crepitant râle. If we wait a few hours more, and examine again, we will find that crepitant râle as well as true respiratory murmur has gone, and all is silent, or there may be bronchial or tubular breathing. Exudation has been poured into the true respiratory system, and consolidation is the result. The seat of crepitant râle is now become the seat of exudation.

If I have studied this matter as correctly as I have carefully, this is the process gone through with, and is the true mechanism of crepitant râle. In this paper I have endeavored to show that the bronchial respiratory system is entirely different from the true respiratory system in anatomy, physiology, object, and use, and that the physical signs of pathological change are equally distinct and different. That the residual air, occupying, as it does, the true respiratory system with force, precludes the idea of currents of air within the lungs, and consequently the accepted theories of the vesicular or respiratory murmurs and of the formation of crepitant râle are necessarily incompetent. If my points are well taken, and the proof convincing, the profession will eventually sustain the truth, and much that has been received as settled literature will be swept away as rubbish, to give room for truer and better grounds of faith.

The composite character of the respiratory murmur must be made evident, analytically as well as synthetically. The two elements, different in cause, character, and seat, must be

individually studied in order that we may correctly understand their significance in pathological changes. We may present their union and the result to the eye, thus:

Broncho-respiratory murmur.	Respiratory murmur.
True respiratory murmur.	

The reasons for introducing a new terminology are, that broncho-respiratory and true respiratory are descriptive, and indicate the seat of the murmurs. The term vesicular murmur was applied by Andral, supposing that it described the minute anatomy of the seat of the murmur.

Later investigations show that the term is misapplied, for there are no structures that may properly be called vesicles in the lungs. Again, the terms vesicular and respiratory have been applied indiscriminately, and their present use would lead to confusion and misapprehension.

In order to practically study these murmurs, it will best be done by selecting a healthy person about twenty-five years of age, with perfectly-developed chest and with muscles not hardened by manual labor.

RESPIRATORY MURMURS.

Placing the ear lightly yet firmly to the chest, allowing the head to rise and fall with the respiration, listen to the breath-sounds. The tidal-air murmur will first catch the ear as modified by the true respiratory murmur, and, as has been described, is like the sighing of the trees over our heads in the forest, when the boughs are gently stirred by the breeze. The character and quality of the respiratory murmur depend upon the absence or excess of one or the other of the composing elements. If the true respiratory murmur be maximum in fulness, the tidal-air sound will be short, only heard in inspiration, and will be of the soft, breezy character described as gently sighing.

While, if the broncho-respiratory be in excess, the tidal-air sound will be harsh, raised in pitch, and will be heard both in inspiration and expiration, and becomes a sign of disease as the other is of health.

BRONCHO-RESPIRATORY MURMUR.

Broncho-respiratory murmur may be studied by forcing the breathing, when it will be heard in both inspiration and expiration, and its harshness, loudness, and pitch, will depend upon the force given to the respiration. This murmur may be heard in its perfection, in the chest of a child, before the true respiratory murmur has been developed.

TRUE RESPIRATORY MURMUR.

The ear accustomed to auscultation, after a few moments of concentration of the attention upon the respiratory murmur, will recognize its dual composition. If the chest be perfect in condition, the tidal-air sound will be heard in inspiration only—soft and short, like breathing gently through the closed teeth—while the true respiratory murmur will be continuous, increasing in fulness in inspiration and diminishing in expiration. It is of low pitch, and is like the roaring of the sea at a distance, the waves breaking on an even shore of sand; or, better still, like the sound made by bees in cold weather, when the hive is tapped with the finger. It is like the innumerable vibrations of the wings of bees, increasing to maximum in inspiration like the coming waves on the sea-shore, and decreasing in expiration as they recede. If the breath be held, this murmur may be heard without admixture, for there can then be no bronchial murmur. The sound is the susurrus of the delicate muscular fibres of the true respiratory system, contracting and relaxing over the dilating and resisting residual air. If the breath be held after a full *inspiration*, the murmur will be at its maximum; if it be held after *expiration*, it will be at its minimum fulness. It cannot be exaggerated, as has been said of the so-called vesicular murmur. If the true respiratory system be unduly dilated, it loses its power to contract on the residual air, and the murmur wholly ceases. This is a sign of emphysema, and is proof of the muscular cause or origin of the sound which may return again after rest.

This murmur only commences to be developed in the child at eight years of age, becomes recognizable at twelve, but is only fully developed at maturity. A beginner in auscultation may recognize true respiratory murmur in a good subject with

ease. But, when the chest has lost its excellent quality as an acoustic chamber by physical changes, resulting from inflammation, or when, from disease of the lung itself, the natural respiratory murmur has been altered or lost, or when the chest, although in its natural conditions, may be covered by thick and hardened muscles, the trained expert ear only can arrive at diagnostic truth.

Many love and enjoy music, and may assist in producing it, but the trained expert alone can lead an orchestra, and harmonize each instrument into a body of perfect song.

These facts, instead of being a matter of discouragement, should induce beginners to pursue auscultation with untiring assiduity, knowing that the end will crown them as masters in physical diagnosis. The ability to recognize true respiratory murmur under any conditions, to analyze its quality, and measure its power, gives its possessor the means of knowing even the approach of that most insidious disease, phthisis, and suggests the method of prevention. The true respiratory system, air-sacs, alveoli, nutrient artery, ganglia of the organic nervous system, with absorbents, etc., all require active use for the prevention of disease. Phthisis does not begin in the lower part of the lungs, which are constantly and actively in motion. If we insure the same kind of exercise in the upper part, we prevent and may even arrest incipient disease.

For more than ten years respiratory murmurs have occupied my diligent attention. The views put forth in this paper were not hastily formed. Some of them are new, and may receive the harsh judgment innovations ever provoke. I do not deprecate criticism, and I am not insensible to the opinions of my professional brethren. I earnestly desire their approval. Many, on whose judgment I rely, believe in true respiratory murmur as well as myself. But, wishing, above all things, for the establishment of truth, I submit the whole subject to this learned Academy, and through it to the profession.

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